QV1

DIGEST D1
JULY 1991

REINFORCED CONCRETE

Better Built with Concrete

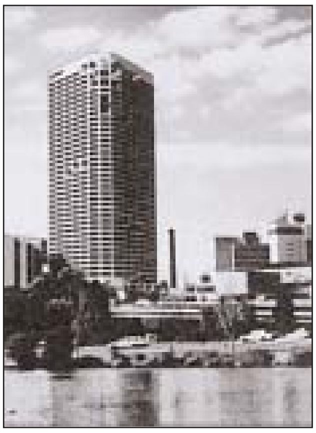
STEEL REINFORCEMENT INSTITUTE OF AUSTRALIA

SRIA

PRE-PLANNING AND CONSTRUCTION OF A MAJOR CONSTRUCTION PROJECT

QV1

Construction progress: mid-April 1999



INTRODUCTION

QV1 in Perth has been one of the most successful commercial building projects undertaken in Australia, with construction of the 42-level tower proceeding at a rapid rate.

A major factor for this success was the substantial amount of pre-planning completed by the project manager/builder Interstruct-Kajima prior to construdion.

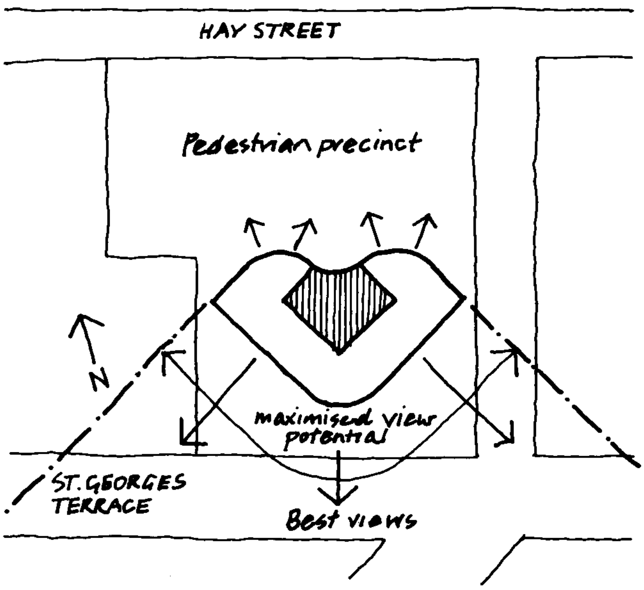
UNIQUE ARCHITECTURE/ PROVEN STRUCTURAL DESIGN

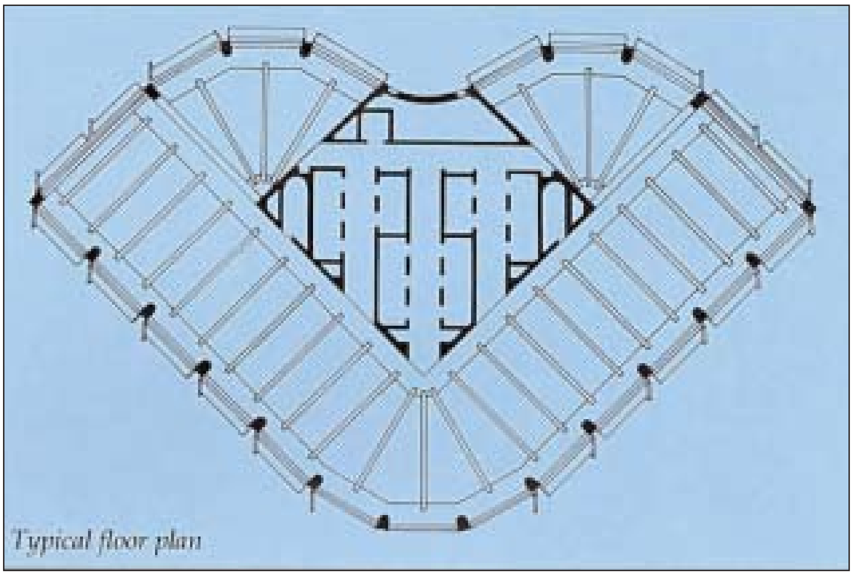
A great deal of the credit for the successful construction of QV1 can be attributed to architect Harry Seidler.

Seidler's brief was to design a structure that provided about 60,000 m^2 of lettable area and maximised the panoramic outlook to the south over the Perth Water and Swan River, the beautifully-landscaped freeway system connecting to the Narrows Bridge and the wide open spaces of Kings Park towards the west. As each individual floor had to provide at least 1600 m^2 of lettable area and offer the greatest flexibility to prospective tenants, a preference for column-free space was expressed.

Further requirements were a nett to gross floor area ratio of at least 80:20 and a construction system that maximised repetitive elements enabling fast erection and optimised floor construction cycles. The need to maximise open urban space on the north of the site in order to provide as much sun and shelter from prevailing winds as possible, and the close visual relationship between the public open space and the Hay Street pedestrianl retail precinct were further considerations in siting the tower.

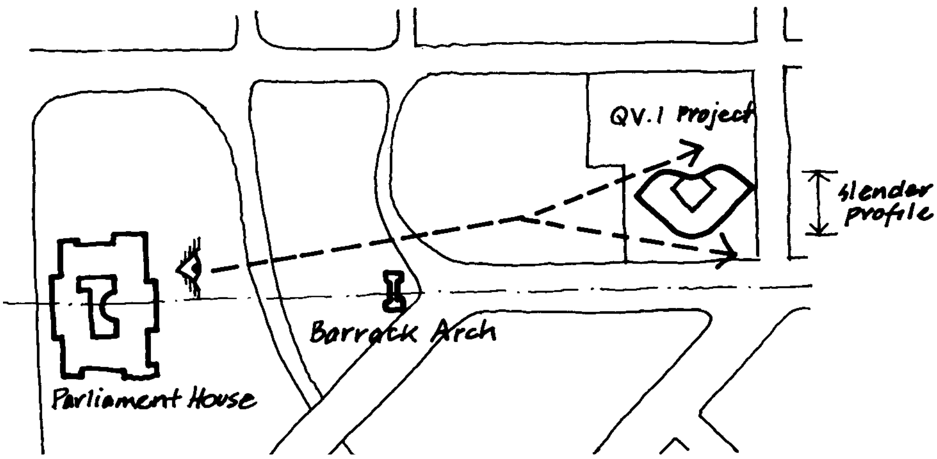
A team comprising representatives from Harry Seidler & Associates, Interstruct-Kajima, Structural Systems Ltd (slipform hire and operation), F&F Constructions Pty Ltd (formwork and concreting contractor), Miller Milston Ferris and Airey Ryan & Hill (Perth-based consulting engineer), began investigating the best, safest and quickest construction methods to utilise.





Planning included:

- Slipform access, platforms etc.
- Power, water and compressed air supply.
- Facilities to be included in the slip.
- Concrete pumping.
- Reinforcement placing including detailing.
- Inclusion/exclusion of walls not structurally required – ie what should/should not be slipped.
- Minimum thicknesses for walls.
- Access for mechanical services installation in confined pipe risers and shafts.
- Survey control.
- Concrete placing with respect to placing rate:
  - minimum requirement for concrete pumping
  - maximum circuit time allowable to prevent a cold joint
  - minimum and maximum slipping rates with respect to concrete setting.



The slipform ran at speeds of up to 600 mm per hour

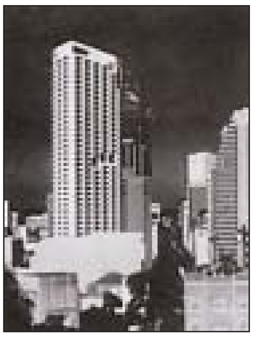
This extensive research and design phase of the project led to a number of design enhancements, all with the intention of reducing construction complexity and time.

A typical example of this was the decision by the team to eliminate a header beam from the core to simplify the operation of the slipform. This resulted in less congestion of reinforcement, as well as less steelfixing and formwork alterations between core pours.

The effectiveness of this decision was such that the slipform often ran at the rate of 600 mm per hour and each lift of the core was generally completed with ease during the five-day working week. The deleted header beam was cast at a later stage with the floor slab, using mechanical connections for reinforcement continuity. Prior to construction, the team also spent a considerable amount of time looking at the placement of essential services such as cranes and concrete-placing booms.

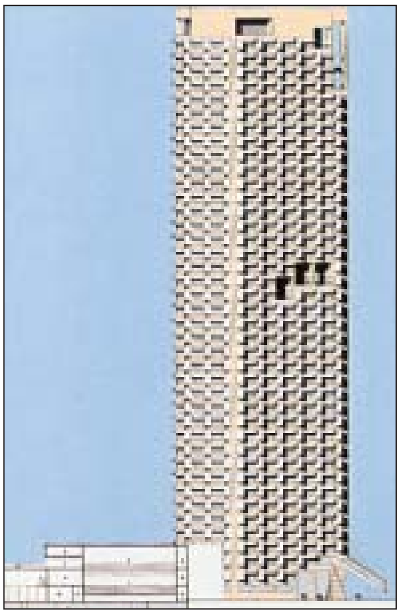
The total site area of 16 386 m^2 was amalgamated from 29 parcels of land

One result of this was that the foundations for the structure were altered slightly so that the tower cranes used the building's footings.
Also, because tower cranes can become a bottleneck on any construction project, a decision was taken early on by the construction team to reduce dependency on the cranes as much as possible.
This was achieved by incorporating three formwork hoists for transporting the formwork between floors, and by designing the perimeter safety and formwork system in such a way that it could be lifted from one floor to another by a simple winch device from the floor above.

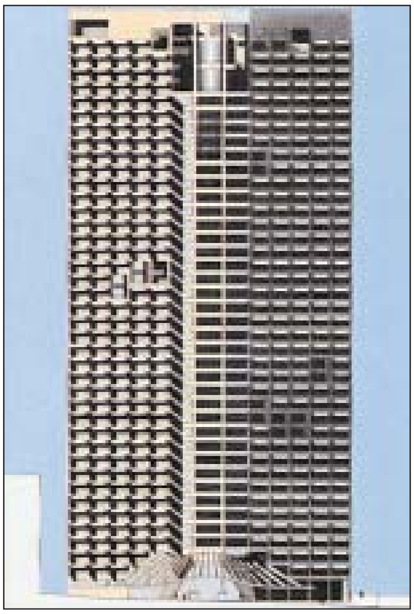


SIMPLIFIED CONSTRUCTION DETAILING

Although the partially-prestressed banded-slab floor system chosen for the construction of the floors of QV1 was a tried and proven design, the design team found ways to maximise the efficiency of the system.



West Elevation

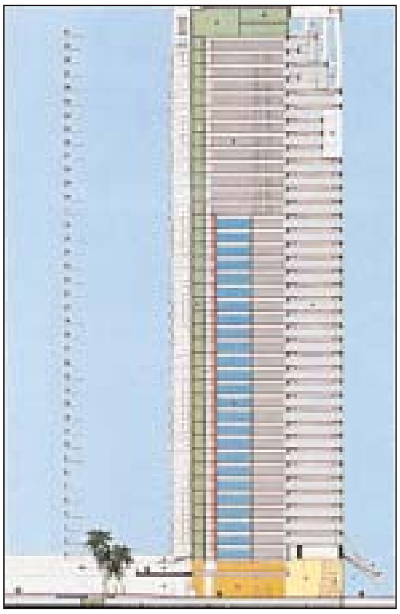


St Georges Terrace Elevation

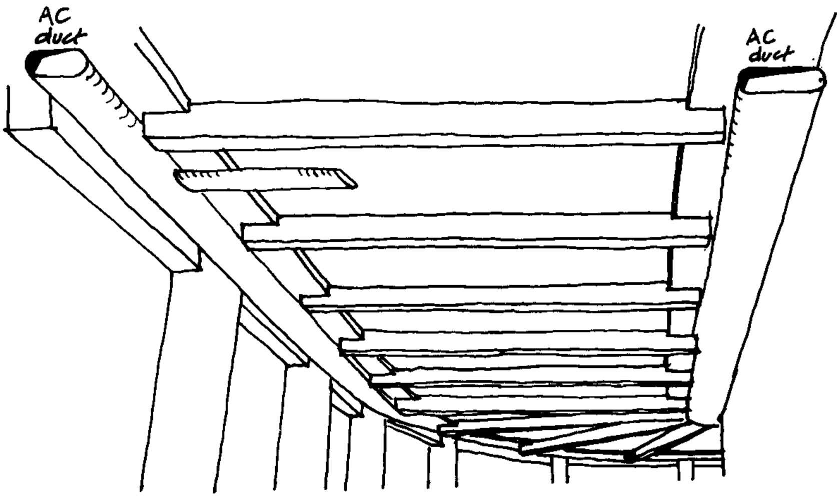
North East Elevation

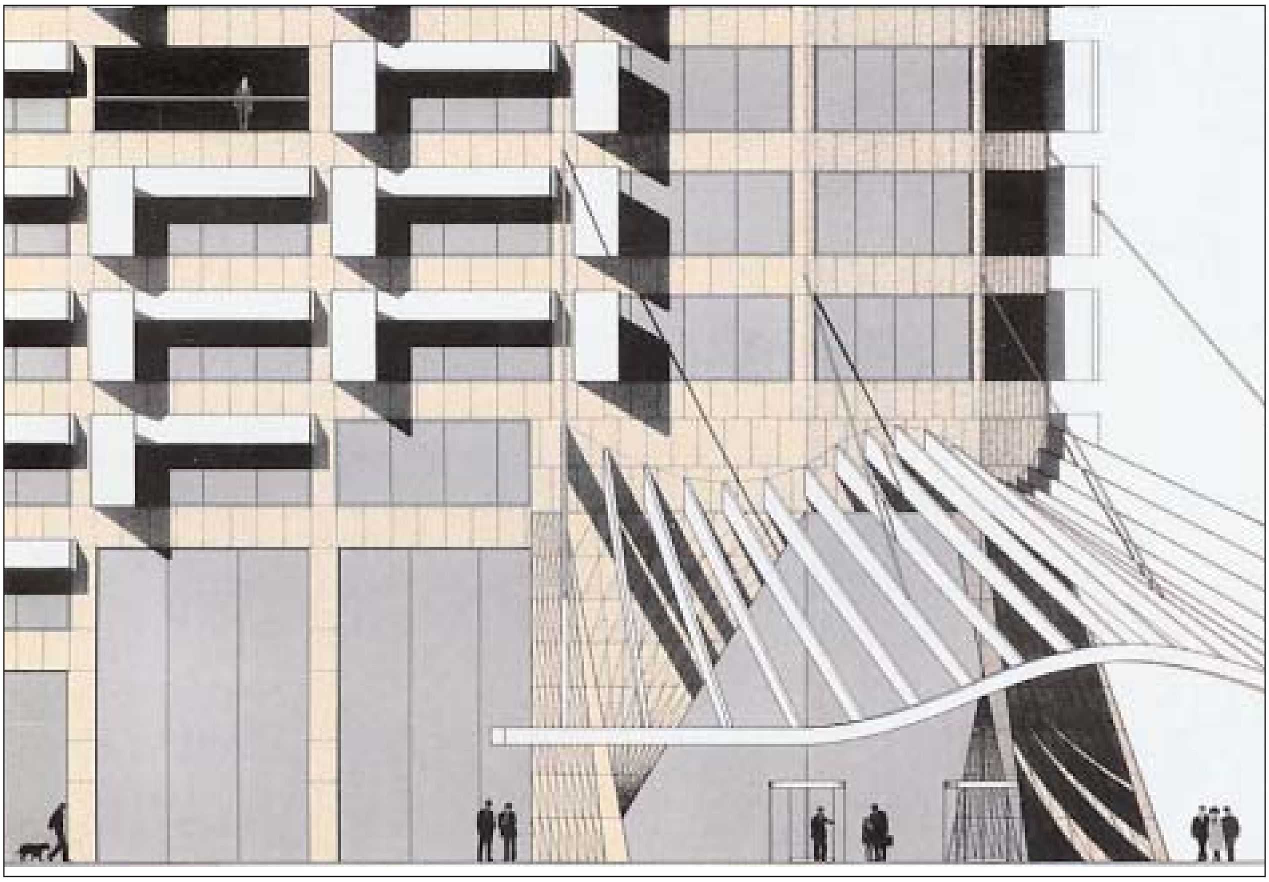
This was done by refining the design and incorparating shear bands near the core walls and perimeter columns, allowing major longitudinal mechanical ductwork to be located within the minimum of space and enabling the floor-to-floor height to be kept to 3.8 m including a 150 mm access floor.

Structurally, the tower is carried by regularly-spaced reinforced-concrete columns, with the floor system consisting of 14.3 m clear-span post-tensioned insitu beams at 3.6 m centres with a 125-mm-thick reinforced concrete floor slab.

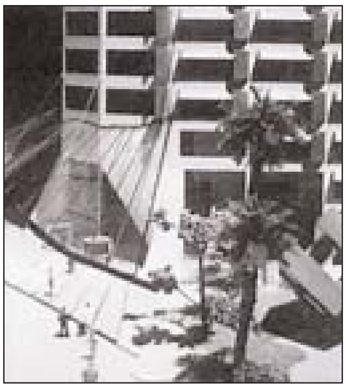


Section





Facade detail



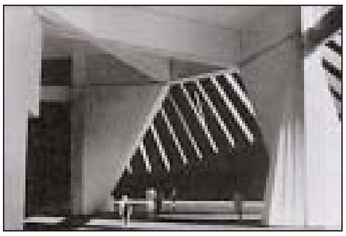
FLEXIBLE FORMWORK DESIGN

A similar amount of pre-planning went into the design of the formwork system for the job – one of the most crucial elements of any reinforced concrete project.

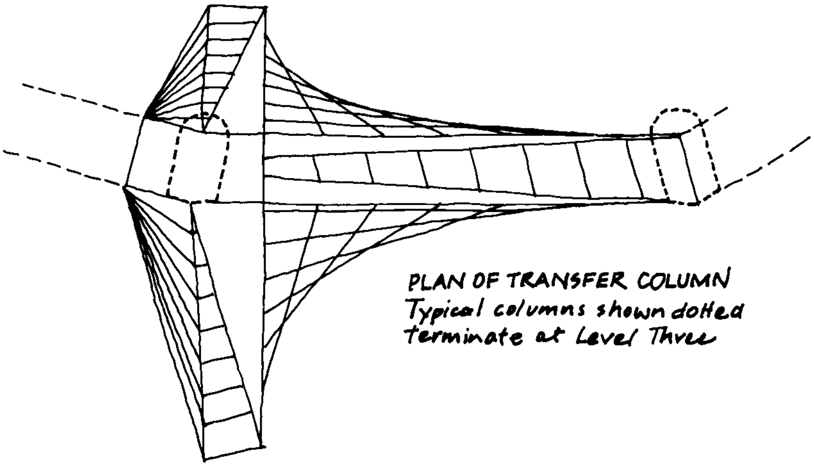
Again drawing on previous experience, Interstruct-Kajima opted for a table-form system which took advantage of the repetition within the tower.

To further enhance the flexibility of the table-form system, metal cover plates were used in conjunction with the tables to provide a large tolerance enabling the tables to be positioned quickly.

In addition, the use of metal cover plates simplified the formwork design as changes in elements such as core wall thickness could be readily accommodated by repositioning the plates.



Construction progress: mid-June 1990

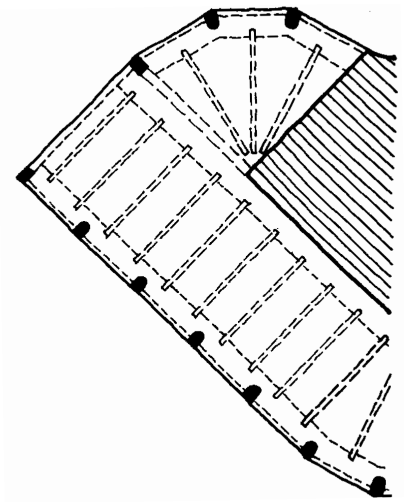


Interstruct-Kajima also opted for a three-floor perimeter safety screen and formwork system which was a first for Perth.

This style of system has become common in the eastern states, but, until this project, had not been featured in any large scale project in the west.

One area where there was no hesitation was in the choice of the formwork system for the core. Perth is 'slipform city'. Almost every core in Perth, even some low- to medium-rise cores of about 6 floors, are slipformed.

Construction progress: mid-February 1991



The high degree of local skill available for setting up and running slipforms saw construction of the core proceed very quickly, however, for practical reasons, the core did not freestand more than four to five floors above the following decks. Six cores on the QV1 carpark were also slipformed.

Four of these were "off-form" slipform where the concrete was finished by trowelling off as the pour proceeded. Harry Seidler & Associates commended the subcontractor, Structural Systems Ltd, for its performance in this area.

COMPLEX FLOOR PLAN, SIMPLE SOLUTION

The use of a tableform assembly to create the intricate radial floor plan of QV1 proved most successful for the builder. Even the complex radial sections proved no problem for the system chosen.

Floors were tackled in three stages with the formwork from each section cycling independently providing continuity of work to the various trades involved.

A significant advantage of this type of construction is that as soon as the formwork is removed, the area is practically free for the following trades to move into, with no fireproofing of structural elements required.

The design layout resulted in the construction area being kept very clean, simple and safe to work on. The post-tensioning strands are located within the reinforcement cages for the beams, simplifying placement of the slab reinforcement and concrete. Prestressing was not so practical, however, for flat-plate construction and the builder changed to conventional reinforced concrete construction methods for most non-typical areas.

The average floor construction cycle, including delays, was about seven days, with four to five day floor cycles achieved on a number of occasions.

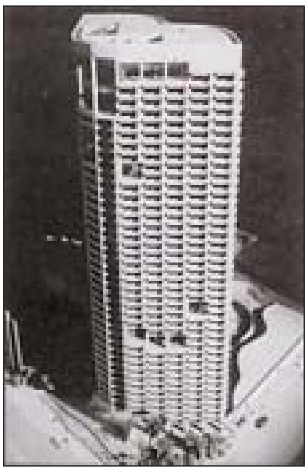
VERSATILITY OF REINFORCED CONCRETE

If QV1's progress is measured against two other major high-rise projects under construction in Perth, Exchange Plaza and Central Park, then the decision to use reinforced concrete for QV1 has certainly paid off for Interstruct-Kajima. Work began on the other projects, which are both steel framed structures, before QV1. Within a few months, the QV1 construction team had caught up with the other buildings and quickly passed them.

As well as speed of construction, reinforced concrete's versatility proved invaluable on QV1.

In this type of development, tenancy requirements often vary from the conceptual design and regular changes are a common occurrence. With reinforced concrete, it is possible to make these changes at short notice – with a steel-framed structure it is much more difficult.

This was particularly the case with the two-level plaza section of the project designed to house mixed retail and commercial facilities.



Client:	Barrack Properties Ltd/Interstruct Holdings Ltd/ Kajima Corporation of Japan
Project Manager:	Interstruct-Kajima
Architect:	Harry Seidler & Associates
Structural Engineers:	Miller Milston Ferris Airey Ryan and Hill
Structural Consultant:	Dr Mario Desideri (Rome)
Mechanical, Electrical, Fire Services and Lifts:	Norman Disney & Young
Quantity Surveyor:	Ralph & Beattie Bosworth

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